

IN THE CLAIMS

What is claimed is:

1 1. A semiconductor device on a silicon substrate, having a device structure including an
2 insulating film formed from gas containing carbon, comprising:

3 a silicon nitride film formed between the insulating film and the
4 silicon substrate for preventing carbon from diffusing to the silicon substrate.

1 2. The semiconductor device according to claim 1, wherein:
2 the insulating film includes tantalum oxide (Ta_2O_5).

1 3. The semiconductor device of claim 2, wherein:
2 the semiconductor device is a dynamic random access memory having
3 a memory cell capacitor film including the tantalum oxide.

1 4. The semiconductor device of claim 3, wherein:
2 the semiconductor device includes a contact which penetrates an
3 interlayer insulating film and is electrically connected with a diffusion layer in
4 the silicon substrate; and
5 the silicon nitride film is formed on the silicon substrate as a carbon
6 diffusion preventing film while traversing a region except a portion for
7 providing the electrical connection between the contact and the diffusion
8 layer.

1 5. The semiconductor device of claim 3, wherein:

2 the semiconductor device includes a contact that penetrates a first
3 interlayer insulating film and is electrically connected with a diffusion layer
4 formed in the silicon substrate and a capacitor contact that is interposed
5 between a lower electrode of the memory cell capacitor and the contact while
6 penetrating a second interlayer insulating film and a third interlayer insulating
7 film; and

8 the silicon nitride film is formed on the third interlayer insulating film
9 while traversing a region except a connection portion between the lower
10 electrode and the capacitor contact.

1 6. The semiconductor device of claim 3, wherein:

2 the semiconductor device includes a contact that is electrically
3 connected with the diffusion layer formed in the silicon substrate while
4 penetrating the first interlayer insulating film;

5 the contact is electrically connected to a capacitor contact that is
6 interposed between a lower electrode of the memory cell capacitor and the
7 contact while penetrating a second interlayer insulating film and a third
8 interlayer insulating film for providing an electrical connection between the
9 lower electrode and the contact; and

10 the silicon nitride film is formed between the second and third
11 interlayer insulating films.

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1 7. A method for manufacturing a semiconductor device on a silicon substrate, having a
2 device structure including an insulating film formed from gas containing carbon, comprising
3 the step of:

4 forming a silicon nitride film between the insulating film and the
5 silicon substrate for preventing carbon from diffusing to the silicon substrate.

1 8. The method for manufacturing a semiconductor device of claim 7, further including
2 the steps of:

3 forming a word line on a silicon substrate;

4 forming the silicon nitride film over the entire surface of the substrate
5 including the word line;

6 forming a first interlayer insulating film on the silicon nitride film;

7 etching the first interlayer insulating film to form a cell contact hole
8 with an etching method selective for the silicon nitride film to expose the
9 silicon nitride film at a bottom of the cell contact hole;

10 selectively etching the silicon nitride film exposed at the bottom of the
11 cell contact hole to expose the silicon substrate; and

12 forming a cell contact plug in the cell contact hole.

1 9. The method for manufacturing a semiconductor device of claim 8, further including
2 the steps of:

3 forming a first capacitor electrode electrically connected to the cell
4 contact plug;

5 forming the insulating film; and
6 forming a second capacitor electrode on the insulating film.

1 **10.** The method for manufacturing a semiconductor device of claim 9, wherein:
2 the insulating film includes tantalum oxide (Ta_2O_5).

1 **11.** The method for manufacturing a semiconductor device of claim 7, further including
2 the steps of:

3 forming a word line on a silicon substrate;

4 forming a first interlayer insulating film on the silicon substrate
5 including the word line;

6 forming a cell contact plug through the first interlayer insulating film
7 to provide an electrical connection with a diffusion layer in the silicon
8 substrate;

9 forming a second interlayer insulating film on the first interlayer
10 insulating film;

11 forming a bit line on the second interlayer insulating film;

12 forming a third interlayer insulating film on the second interlayer
13 insulating film including the bit line;

14 forming a capacitor contact plug through the second and third
15 interlayer insulating films to provide an electrical connection to the cell
16 contact plug; and

17 forming the silicon nitride film on the third interlayer insulating film

18 and capacitor contact plug.

1 12. The method for manufacturing a semiconductor device of claim 11, further including
2 the steps of:

3 forming a fourth interlayer insulating film on the silicon nitride film;

4 forming a capacitor formation section in the fourth interlayer
5 insulating film to expose the silicon nitride film; and

6 etching the exposed silicon nitride film to expose the capacitor contact
7 plug.

1 13. The method for manufacturing a semiconductor device of claim 12, further including
2 the step of:

3 forming a capacitor including the insulating film in the capacitor
4 formation section.

1 14. The method for manufacturing a semiconductor device of claim 7, further including
2 the steps of:

3 forming a word line on a silicon substrate;

4 forming a first interlayer insulating film on the silicon substrate
5 including the word line;

6 forming a cell contact plug through the first interlayer insulating film
7 to provide an electrical connection with a diffusion layer in the silicon
8 substrate;

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9 forming a second interlayer insulating film on the first interlayer
10 insulating film;
11 forming a bit line on the second interlayer insulating film;
12 forming a third interlayer insulating film on the second interlayer
13 insulating film including the bit line;
14 forming the silicon nitride film on the third interlayer insulating film;
15 and
16 forming a capacitor contact plug through the second and third
17 interlayer insulating films and the silicon nitride film to provide an electrical
18 connection to the cell contact plug.

1 15. The method for manufacturing a semiconductor device of claim 14, further including
2 the step of:

3 forming a capacitor including the insulating film and having a
4 capacitor electrode electrically connected to the capacitor contact plug.

1 16. The method for manufacturing a semiconductor device of claim 7, further including
2 the steps of:

3 forming a word line on a silicon substrate;
4 forming a first interlayer insulating film on the silicon substrate
5 including the word line;
6 forming a cell contact plug through the first interlayer insulating film
7 to provide an electrical connection with a diffusion layer in the silicon

8 substrate;

9 forming a second interlayer insulating film on the first interlayer

10 insulating film;

11 forming a bit line on the second interlayer insulating film;

12 forming the silicon nitride film on the second interlayer insulating film

13 including the bit line;

14 forming a third interlayer insulating film on the silicon nitride film;

15 etching the third interlayer insulating film to form a contact hole and

16 expose the silicon nitride film at a bottom of the contact hole;

17 etching the silicon nitride film at the bottom of the contact hole to

18 expose the second interlayer insulating film;

19 etching the exposed second interlayer insulating film at the bottom of

20 the contact hole to provide a capacitor contact hole including the contact hole;

21 and

22 forming a capacitor contact plug through the second and third

23 interlayer insulating films to provide an electrical connection to the cell

24 contact plug.

1 17. The method for manufacturing a semiconductor device of claim 16, further including

2 the step of:

3 forming a capacitor including the insulating film and having a

4 capacitor electrode electrically connected to the capacitor contact plug.

1 18. A method for manufacturing a semiconductor device on a silicon substrate, having a
2 memory cell including a capacitor insulating film formed from gas containing carbon,
3 comprising the step of:

4 forming a silicon nitride film between the capacitor insulating film and
5 the silicon substrate for preventing carbon from diffusing to the silicon
6 substrate.

1 19. The method of manufacturing the semiconductor device of claim 18, wherein:
2 the capacitor insulating film includes tantalum oxide (Ta_2O_5).

1 20. The method of manufacturing the semiconductor device of claim 19, wherein:
2 the capacitor includes an electrode having a hemi-spherical grain
3 structure.

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